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Effect of irrigation efficiency enhancement on crop productivity and irrigation water availability under climate change in Nepal

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Abstract

Crop production is predicted to be affected by climate change in terms of drought. That is the reason Nepal is expanding its irrigation facilities as adaptive measure in terms of water availability. However, water-efficient irrigation methods need to be used in the irrigation expansion due to the increasing water scarcity in Nepal. Therefore, in this study we assess the influence of three different irrigation efficiencies on potential crop productivity of rice, maize and wheat and on irrigation water savings under three climate change scenarios. The scenarios are based on SSP1–2.6 (low emissions due to strong mitigation), SSP3–7.0 (high emissions), and SSP5– 8.5 (extreme emissions/unmitigated) and are run with three general circulation models (GCMS) GFDL-ESM4, IPSL-CM6A-LR and MPI-ESM1–2-HR. The data are bias adjusted as part of the Coupled Model Intercomparison Project phase 6 (CMIP6) and acquired from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP3b) database. District and province level comparison of yields are carried out for the current time (2015 to 2022), near future (2023 to 2050), mid-century (2050 to 2075), and end century (2075 to 2100). The management scenarios are: (1) current management with an average irrigation efficiency of 30 %, (2) stress-triggered irrigation with efficiency 70 %, (3) stress-triggered irrigation with efficiency 50 %, and (4) stress-triggered irrigation with efficiency 30 %. For scenarios 2, 3 and 4 stress triggered mineral phosphorous and maximum annual 300 kg of mineral nitrogen per hectare is applied. We identified that on national scale yields can be increased by 1 t ha^{-1} for Maize, 0.5 t ha^{-1} for Rice and 1.5 t ha^{-1} for Wheat with an increase of irrigation efficiency from 30 % to 70 %. The results also showed the substantial water savings (up to 200 mm) could be attained if surface irrigation efficiency increases from the current value of 30 % to 70 %. The comparison showed the importance of efficient irrigation as a reliable adaptive measure for future climate change conditions.

Keywords: Climate change adaptation, irrigation efficiency, irrigation water management

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